to approach the ideal than anything else. The electric system of ignition enables the moment of ignition to be varied exactly as required, giving very complete control over the speed and power of the engine within limits. However, these limits constitute the weak points in what might otherwise be a perfect system. Hot as the spark is, it is unable to ignite with readiness mixtures which have more than a certain percentage of air, and the ignition, being so extremely local, prevents the flame in a weak mixture being readily transfused throughout the whole of the charge. Improvements in the original system have been in the direction of substituting mechanical for chemical means of production of the current. Owing to the fact that a slight difference in the mixture or in the amount of compression entails an alteration in the time when the charge must be ignited in order to obtain the best result, and owing to the difficulty of maintaining each cylinder of an engine in identical conditions in these respects, it is obvious that an ignition system that does not take such variations into account cannot be perfect.

The Ackermann system of steering, invented nearly 100 years ago for horse-drawn vehicles, is now almost universally employed for all road motors, except traction engines. Each of the steering wheels turns separately on a vertical pivot, which should, theoretically, pass centrally through the vertical plane of the wheel and its contact with the ground. An obstacle met by the wheel would then have no tendency to disturb the steering of the car. The said arrangement is difficult to obtain mechanically, and a compromise is sometimes made by inclining the pivots or by inclining the wheels. It is not easy to see how the best types of the present system can be improved, although it must be admitted that none is perfect.

Horizontal cylinders may be lubricated by feeding oil through a hole in the cylinder on to the piston, allowing a portion to flow through a hole in the piston to lubricate the gudgeon pin. The oil is drained away at the front end of the cylinder, and is not used again. In vertical engines splash lubrication is generally employed for the lubrication of the piston, gudgeon pin, and in many cases the crank shaft and other engine bearings. The oil in this system is thrown up from the crank chamber by the crank dipping into it. At the best it seems to be a happy-go-lucky method of a most unscientific order; the only thing which can be said in its favour is that in actual practice it has been found to work. For crank shafts and similar bearings a forced feed system would be better, provided some perfect system for road motors could be found of freeing entirely the oil from grit before re-feeding it to the bearings. Bath lubrication of gear wheels is effective as regards lubrication, but absorbs power in churning up the oil.

There is still a good deal that can be effected in design in reducing friction by the substitution of ball or roller bearings for plain ones in suitable places, and by the use of metals having a low coefficient of friction. There are many ways in which power can be lost between the engine and the road wheels. None of the many forms of friction clutch can be depended upon not to slip in the way that a clutch which is positively engaged can. The use of Hooke's universal joints involves loss in transmission, as is demonstrated by the rapidity with which they often wear. The total transmission losses are not accurately known under road conditions, but it may be indirectly estimated that such losses may amount to from 20 per cent. to 40 per cent., or even more.

The advantages of pneumatic tyres, owing to their resilience and low resistance, are counterbalanced by their high cost, rapid wear, and vulnerability. Methods of decreasing the vulnerability are only obtained at the sacrifice of other, and possibly more important, qualities. Owing to the large area of contact with the ground, and consequent low pressure per unit of contact area, the coefficient of friction is so small that skidding occurs if the road is greasy. No remedy has been found which does not impair the action of the tyre as a pneumatic one. Again, owing to the rapidity of recovery of the tyre on passing over an obstacle, oscillatory movement of the vehicle is started, and, given favourable conditions of speed and road, may be maintained, or even increased, to a dangerous extent. A partial remedy exists in the shock absorber applied between the sprung and unsprung portions of the vehicle. An inherent defect of the pneumatic tyre is its dust-raising properties. The tyre raises the dust, and the eddies produced by the passage of the car scatter it far and wide. This subject is one which is attracting the attention of the authorities representing road-makers and users. So far, the only effective remedy has consisted in treatment of the surface of the road.

The study of the composition of the exhaust gases is of importance. It ought to be possible to ensure that the exhaust gases contain not more than 1 per cent. of carbonic oxide. Governing by retarding the ignition is effective, but is objectionable on account of its liability to increase the percentage of CO in the exhaust; it is also unscientific, and very wasteful of fuel.

To obtain an average speed of twenty miles per hour, experience tells us that the maximum speed will not be less than 50 per cent. greater than the average during some periods of the journey; assuming a moderate efficiency of transmission of power, the provision of an engine capable of giving 1 brake-horse-power per cwt. of the gross weight of the vehicle and its load of passengers, &c., would not be excessive.

Deductions made from data known to be approximately correct for the speed, power, and wind area of various cars having ordinary touring bodies lead to the formula $P=0{\cdot}0017AV^2$, in which P=resistance in lb. per square foot, A=projected area of car in square feet, and V=velocity in feet per second. Experiments are needed to provide data as regards the form of car offering the least resistance to the air.

The gross ton-miles which should be obtained from a gallon of petrol of about 0·720 specific gravity at a speed of twenty miles per hour should not fall below thirty under ordinary conditions. There is room for improvement in this. Many other items, tyres especially, have to be considered, which swell the bill to such an extent as to render the cost of fuel but a small part of the whole.

The weight of a pleasure motor-car is high compared to the useful load of passengers. The useful weight in this case would be about one-quarter of the weight of the vehicle. Medium-weight passenger or goods' vehicles may carry a useful load of three-quarters the weight of the unladen vehicle; heavy vehicles having a slow speed may carry a load equal to the weight of the vehicle. It would appear that some improvement may be reasonably looked for in the reduction of the weight of the car as compared with its useful load.

Brakes on the steering wheels give immunity from skidding, but are very difficult to arrange for. It is best to apply both brakes required by law to the driving wheels, rather than to have one of them applied to the secondary transmission shaft. The distance in which a car can be pulled up without damage to the tyres on an ordinary road and under normal conditions may be approximately found from the formula $S=0{\cdot}04V^2$, where V is in miles per hour and S is the distance in yards in which the car should come to rest. At ten miles per hour it should stop in 4 yards, and at twenty miles per hour in 16 yards. These distances are greater than is desirable, and also greater than most drivers would be prepared to admit, probably owing to time, and not distance, being the factor that a driver judges by when called upon to stop quickly. Improvement is only to be sought for in increasing the surfaces of adhesion, as by braking all four wheels, or by more equal distribution of the braking effect than we have at present.

Petroleum spirit is practically the only fuel employed; other fuels which might be used are petroleum, paraffin, benzol, and alcohol. Suction gas producers may be used for the heavier classes of vehicles.

THE "BROMOIL" PROCESS.

ABOUT five years ago Mr. G. E. H. Rawlins introduced, as a practical method of making photographs, a process described fifty years previously by Poitevin. Paper coated with gelatin is sensitised by soaking it in a solution of potassium bichromate, dried, and exposed under a negative. Where light has acted the gelatin is rendered less able to absorb water, so that if the print

is moistened, and a roller charged with a greasy ink is passed over it, the ink is taken up by the print more readily where the light has produced the most change and the water has been the least absorbed. The use of rollers for the application of the ink soon gave way in favour of brushes. This process commended itself to many photographers, especially those who desired to "control" their prints, that is, to produce what they desired rather than what they were able to secure by photographic methods, for it is possible to put on much or little ink, and to reduce or increase the quantity in the various parts of the print as the taste of the worker may dictate. Obviously a wide choice of colours is available, and the method has the advantage of giving the peculiar richness and depth of tone associated with oil colours.

About a year ago it was found possible to render bromide enlargements available for this process, the silver image in the enlargement effecting the reduction of the bichromate. Thus no large negative is needed, and no exposure to light after the bromide enlargement has been made. Mr. F. J. Mortimer calls this last method of work the "bromoil" process, and he has now on view at the house of the Royal Photographic Society, 66 Russell Square, more than fifty examples of his own work. The exhibition will remain open, free on presentation of visiting card, daily from 11 a.m. to 5 p.m., until June 8. Mr. Mortimer has been known for a considerable time as the producer of fine marine and coast-scenery photographs, but here he shows also landscapes and portraits of various kinds. Those who are interested in such methods of work will get a better idea of the possibilities of the "bromoil" process by a study of these examples than they have ever had an opportunity of getting before.

ARBORICULTURE IN GERMANY.[1]

THE German Arboricultural Society came into existence in the year 1892, and now has a membership of 1800, of whom 120 attended its annual meeting in August, 1908, in Alsace Lorraine; Strassburg and Colmar being its headquarters. The president is Count Schwerin, who is ably helped by the secretary, L. Beissner, the conifer expert. The report just issued gives a detailed account of the meeting. The first three days were devoted to the reading of papers now published. Then followed visits to private parks, where many fine exotic and native trees, some of which are illustrated in the report, were seen. Each member, who was himself listed and conspicuously numbered, received a numbered list of the trees worthy of note in each centre visited. The list gave the name, girth, height, and age of each tree, with further remarks in some cases.

The lists embodied in the report may serve as an indication of the perfection of arrangement which characterised the meeting. Everything was planned to the minute, and nothing was allowed to interfere with the programme. Thus at Ollweiler Prof. Engler was in danger of being left behind after a hurried inspection of a fine specimen of *Quercus sessiliflora*, 250 years old. La Schlucht and Hoheneck gave a peep into the forests on the slopes of the Vosges Mountains. This district, with Longuemer and Retournemer, was also visited by the botanists fresh from the Botanical Congress at Strassburg, and was full of interest.

A few only of the articles in the report can be noticed. In addition to many contributions by the president, including one on the hardiness of certain trees, and one by Beissner on conifers, C. S. Sargent, an honorary member, gives an illustrated account of the Arnold Arboretum, Koehne writes on Taxodium, Forster on exotic trees, Berg on *Pseudotsuga Douglasii* in Europe, while St. Olbrich and Hübner write on trees suitable for avenues and towns, and Sprenger and Rehder on new or rare arboreous plants.

Following on more than twenty important papers there are many smaller contributions. One of these may be noticed. Unger, just returned from a residence of twenty years in Japan, proposed the cultivation of *Broussonetia papyrifera* for the supply of Japanese paper. As twenty degrees of frost is fatal to the plant, Germany was declared by experience unsuitable for the industry. Several pages are devoted to descriptions, in Latin in many cases, of new species or forms. A useful feature is a correspondence section for the supply of information on such subjects as Platanus diseases, and pitch pine. A place is also found for reviews of books on trees. Obituary notices appear, including one on John Booth, a Teutonic Scot, who strove successfully to introduce exotic timber trees into Germany, and one on George Nicholson, of Kew. Altogether the publication is astonishingly rich in contents of wide and general interest, and is very cheap.

A curious feature of the report is the entire absence of any reference to the many beautiful illustrations, there being sixteen full-page ones and many others incorporated in the text. Members of the Society, by payment of an annual subscription of five marks, obtain the report, certain privileges at the meeting, and supplies of packets of seeds as well as of living plants. This result is mainly due to the enthusiastic devotion and organising skill of the president, who has personally made all the detailed arrangements for the meeting at Cottbus in 1909, and provided the necessary particulars for two alternative places of meeting in 1910. The society would be delighted, I learnt, to visit the British Isles in the company of British arboriculturists. Cannot this be arranged for by the three British arboricultural societies?

A re-issue of the reports for the year 1892–1901, in one volume of 500 pages, at not more than nine marks, is offered for subscription. T. J.

[1] Mitteilungen der deutschen dendrologischen Gesellschaft. No. 17, 1908. Pp. 285; with many illustrations. (Bonn—Poppelsdorf: L. Beissner, Geschäftsführer der Gesellschaft.) Price 5 marks.

GROWTH OF NERVE FIBRES.

THE view that each nerve fibre develops as an independent outgrowth from a nerve-cell, finally becoming united to other tissues (*e.g.* muscle fibres) in the periphery of the body is associated especially with the name of His, and has been accepted by the majority of embryologists. Those who have worked at the question of nerve repair or have studied the mechanism of the regeneration of nerve fibres which leads to restoration of functions are divided into two camps; the majority hold, as Waller originally taught, that the nerve fibres grow in a distal direction from the cut stump attached to the central nervous system, ultimately finding their way into the peripheral segment. A minority of researchers hold the contrary view, namely, that restoration occurs in the peripheral segment independently of connection with the central nervous system.

Within the last year, Mr. Ross Harrison, of Yale, has demonstrated the correctness of the views of His in a very remarkable way. He has actually seen the fibres growing outwards in embryonic structures. Pieces of the primitive nervous tube which forms the central nervous system were removed from frog embryos and kept alive in a drop of lymph for a very considerable time; the cilia of the neighbouring epidermic cells remained active for a week or more; embryonic mesoblastic cells in the vicinity were seen to become transformed into striated muscular fibres, and there was therefore no doubt that even under these artificial conditions—rendered necessary for microscopic purposes—life and growth were continuing. From the primitive nervous tissue, and from this alone, nerve fibres were observed growing and extending into the surrounding parts. Each fibre shows faint fibrillation, but its most remarkable feature is its enlarged end, which exhibits a continual change of form. This amœboid movement is very active, and it results in drawing out and lengthening the fibre to which it is attached, and the length of the fibre increases at the rate of about 1 micromillimetre per minute. Those interested in this subject should refer to Mr. Harrison's last paper, published in the *Anatomical Record* (Philadelphia, December, 1908), where they will find figures representing the growing fibres in various lengths drawn at intervals of half an hour or thereabouts.

Such observations show beyond question that the nerve fibre develops by the overflowing of protoplasm from the central cells and thus give us direct ocular evidence in